# Synergistic use of AIRS/MODIS by using spatial and spectral response information

## An investigation of radiance differences sorted by cloud and atmospheric quantities

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# Overview

- Why combine AIRS and MODIS ?

- How to combine ?

- Comparison with spatial and spectral information

- Comparison with Level 2 - Data

- Conclusion

# Why combine?

## Specifications of the instruments



Aqua's Instruments
1- AIRS
2- AMSR-E
3- AMSU
4- CERES
5- HSB
6- MODIS

## AIRS :

- Located on Aqua
- Scan width of 1650 km (90 scans)
- High Spectral Resolution in IR (2378 channels from 3.7 – 15.4 μm)
  - includes absorption lines of $CO_2$, $H_2O$, $O_3$,…
- Field of View is approx 1.1°
  (13.5 km at NADIR)
- Collocated with AMSU (Microwave)
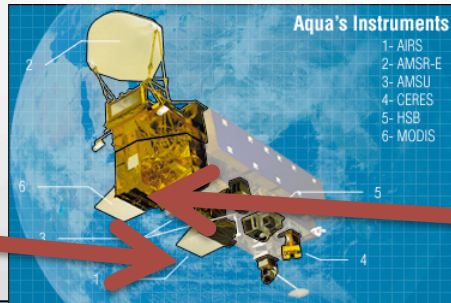
## MODIS :

- Located on Aqua (and Terra)
- Scan width of 2330 km (1354 scans)
- 36 Broadband-Channels between (0.4-14 μm)
  - includes channels for $CO_2$-slicing
  - includes 1.38 μm for Ci-detection
- Field of View is approx 0.08° (1 km at NADIR)
- A lot of Level 2- products available

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# Why combine?

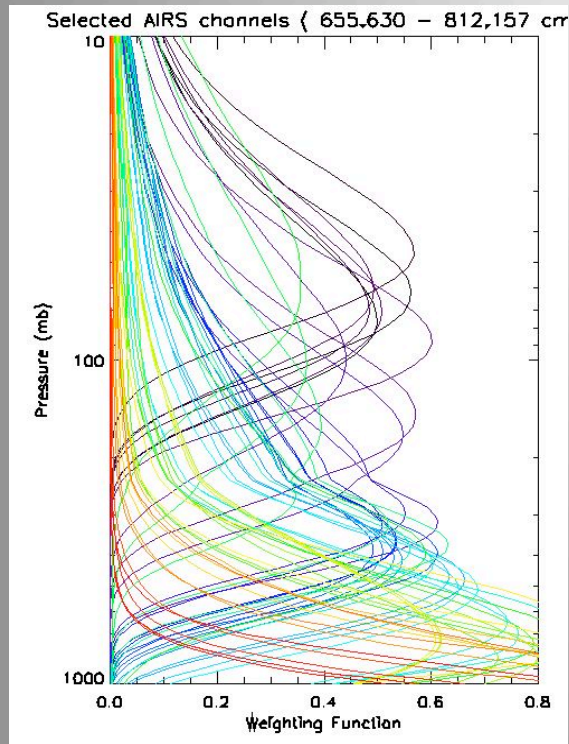## A lot of MODIS-channels overlap with AIRS in the Infrared

Black line: AIRS
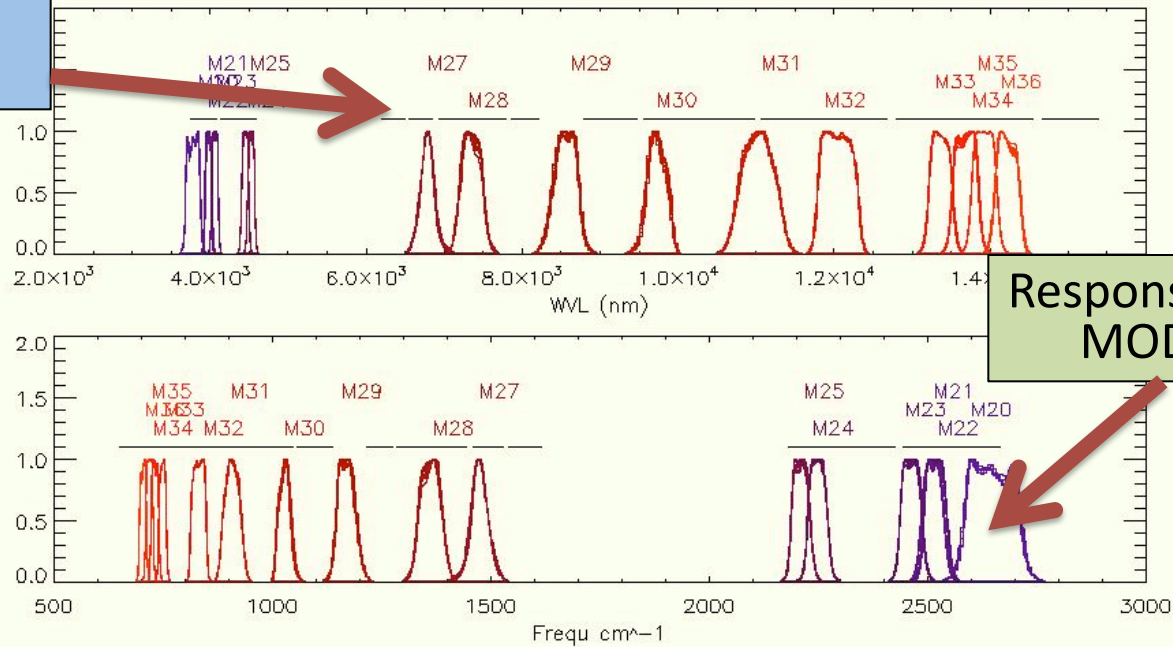
Response curves: MODIS

# Why combine?

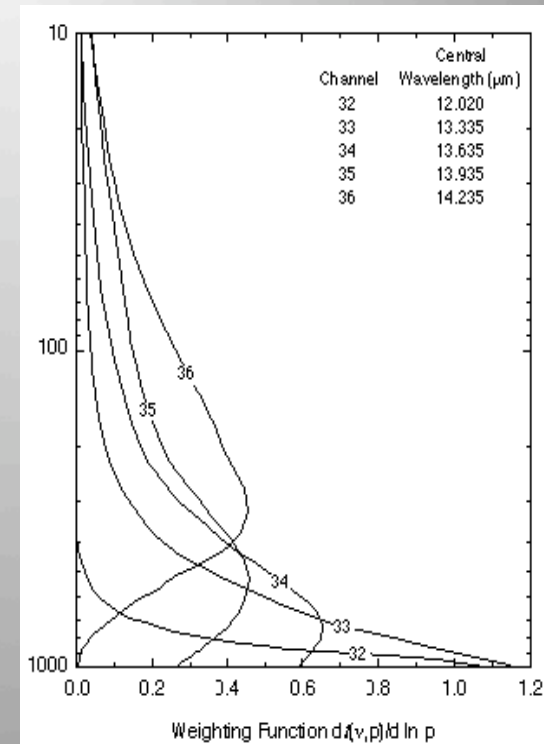### Sensitivity of the channels in IR

AIRS-Channels for cloud clearing

MODIS Channels for $CO_2$-Slicing

AIRS has more channels
and therefore better
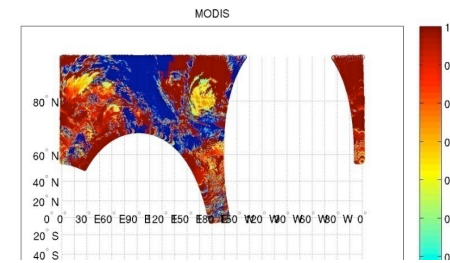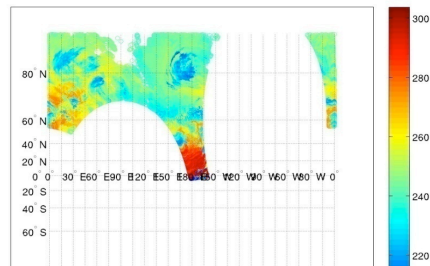sensitivity of cloud top
height – But worse
spatial resolution

# Why combine?

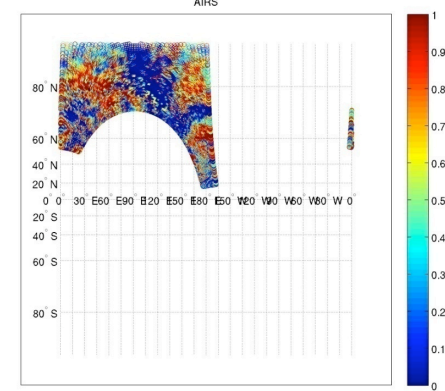Comparison of "stand alone products" retrieved cloud properties

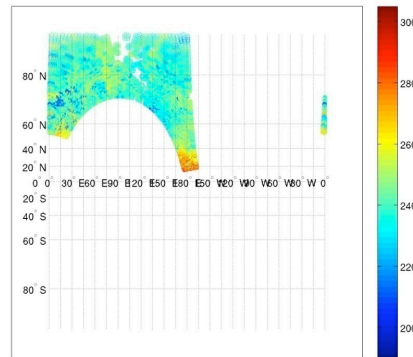Cloud Top Temperature

Effective Cloud Fraction

MODIS

AIRS

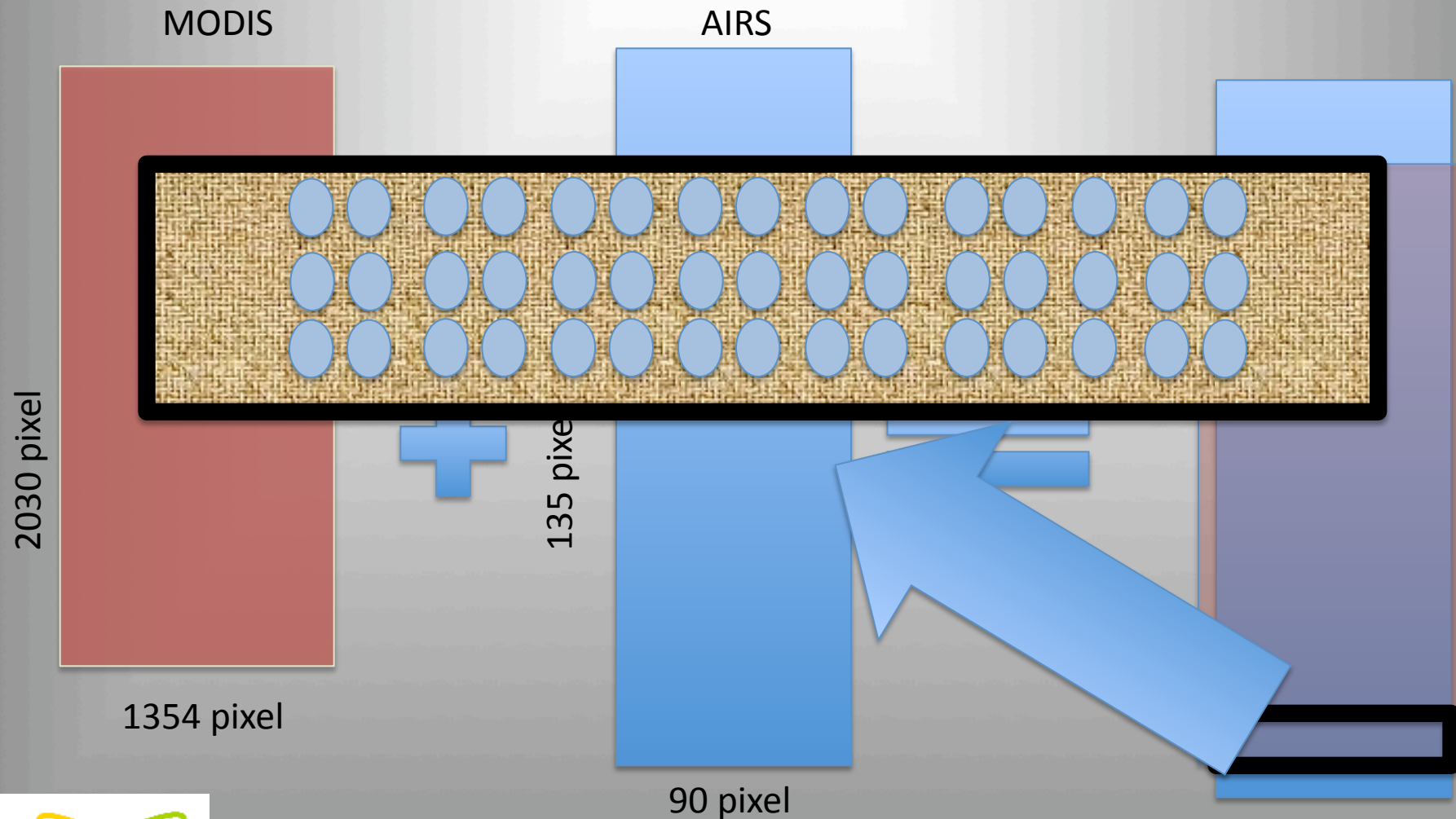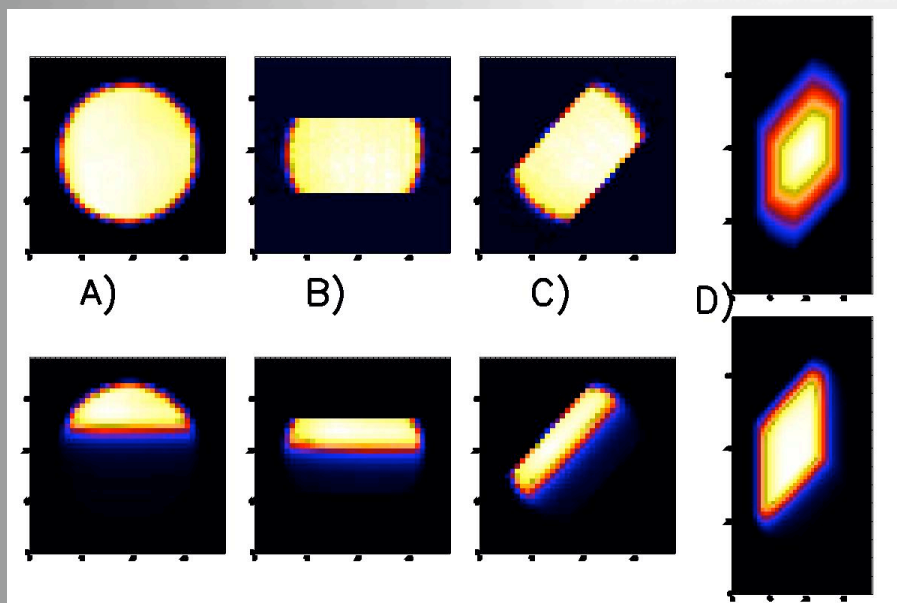# How to combine?

## Comparison of one scene

MODIS

AIRS

2030 pixel

135 pixel

1354 pixel

90 pixel

# How to (better) combine?

## The crux - or advantage - of spatial response of AIRS



A)    B)    C)    D)

Channel 1

Channel 2265

Within one AIRS Channel are several MODIS measurements, which have to be weighted according to the MODIS spectral response

there exist pre-launch-measurements
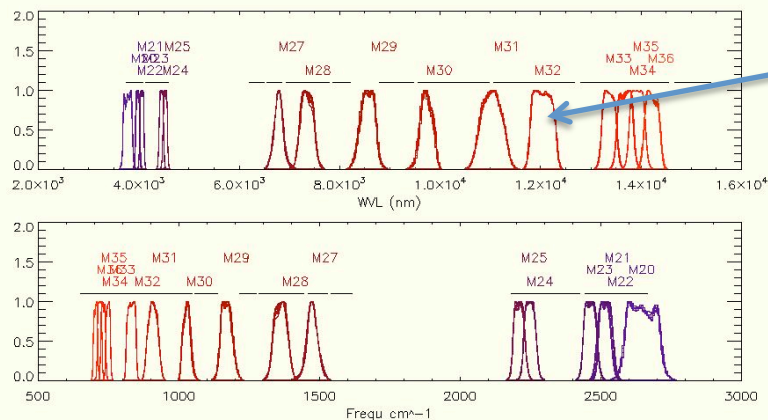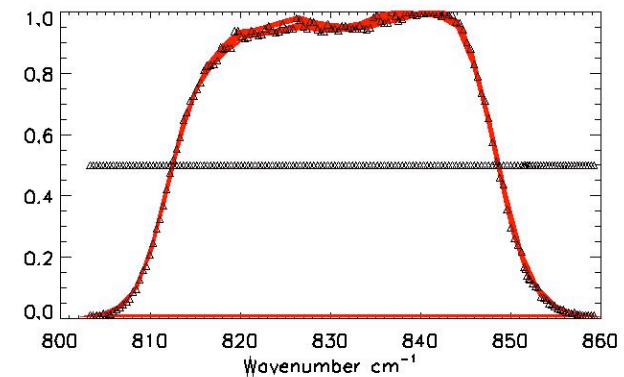
| ROUND pre-launch measured | TRUNCATED Include blinds | ROTATED Dependence on scan angle | SMEARED Take into account moving |
|---|---|---|---|

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# How to combine?

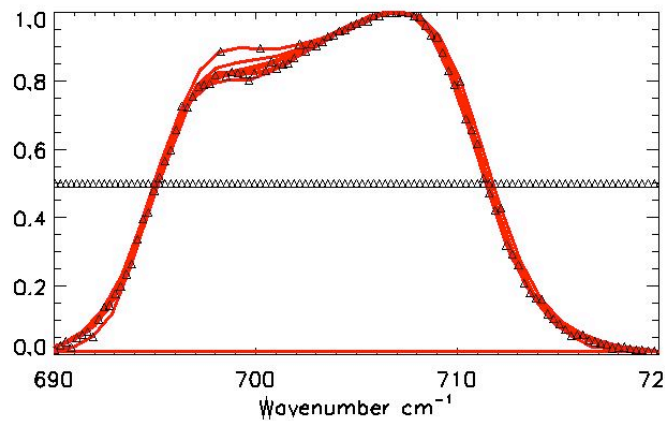The crux - or advantage - of spectral response of MODIS



Within one MODIS Channel are several AIRS Channels which have to be weighted according to the MODIS spectral response
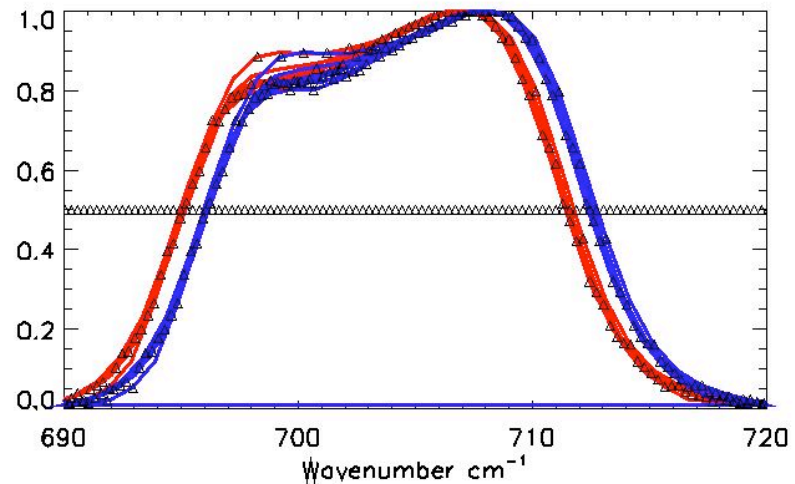
there exist pre-launch-measurements

# How to combine?
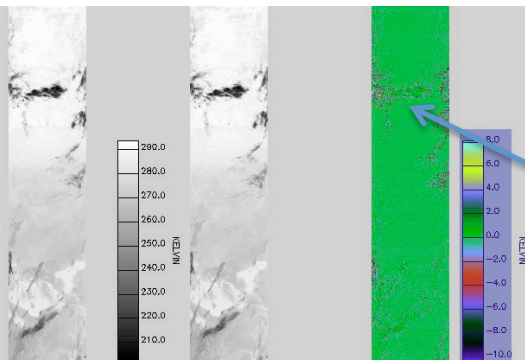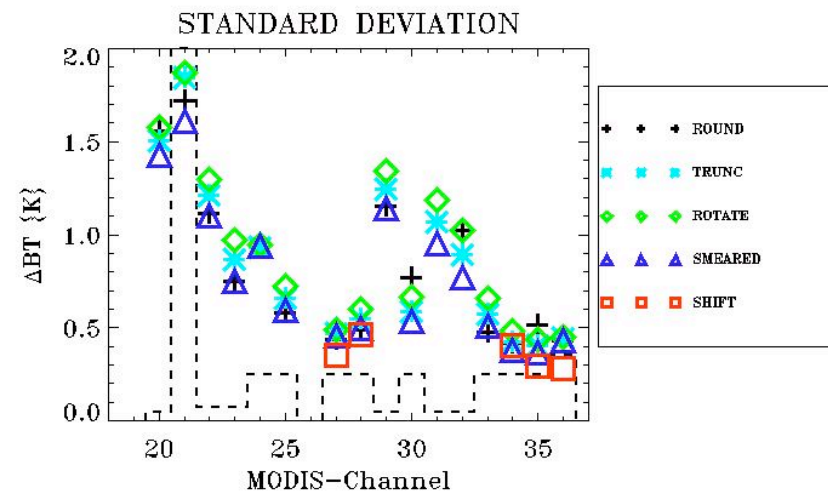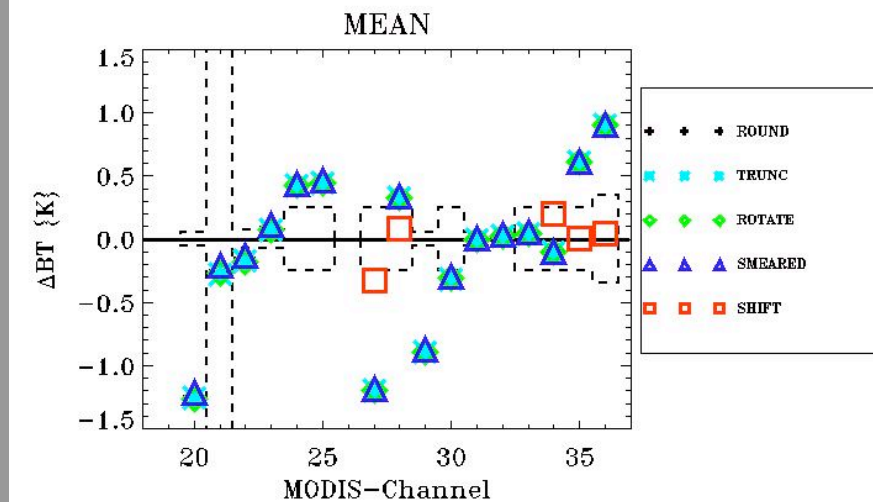## The spectral shift by Tobin et al., 2006



**Example: Channel 36**
**Shift by 5 cm$^{-1}$**



Tobin et al, 2006 proposed the shift of the MODIS response response functions for several channels
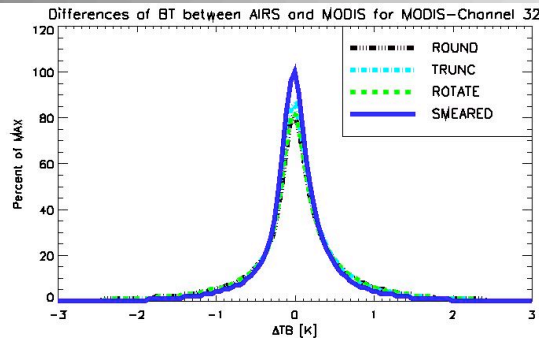
# Comparison

## Comparison of Radiances/Temperatures



The main "problematic areas" are cloud edges.
The use of accurate spatial and spectral response helps to reduce the variation
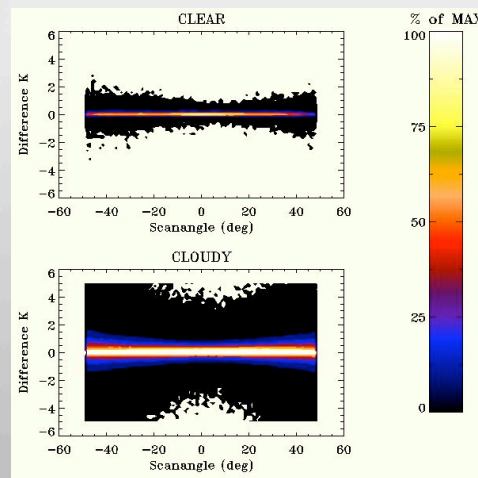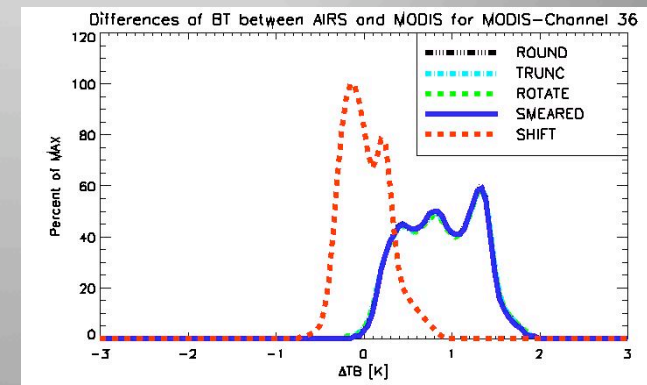
# Comparison
## Channels and Scan-Angle

So, the variance is reduced ….

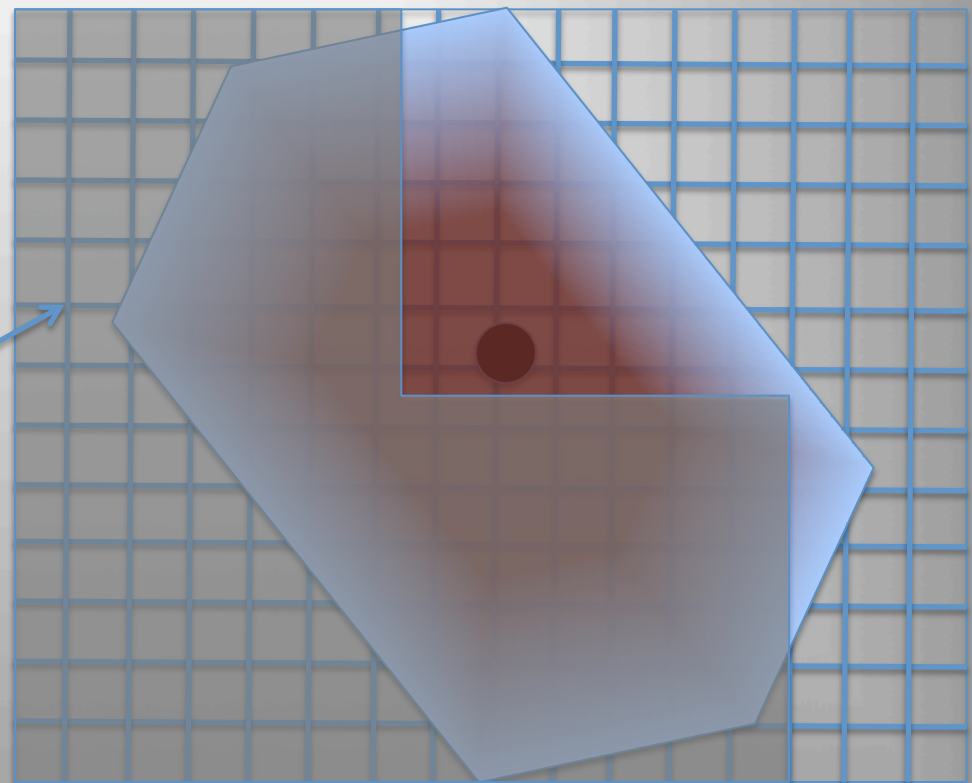… the scan angle dependence is reduced ….

… but there are still strange features.

# Including Level 2 Data

## Use of MODIS L2-data to look onto cloud coverage within AIRS

We can better calculate the average amount of Clouds, Cirrus, Aerosol, surface, ... within a "big" AIRS-footprint, by using MODIS
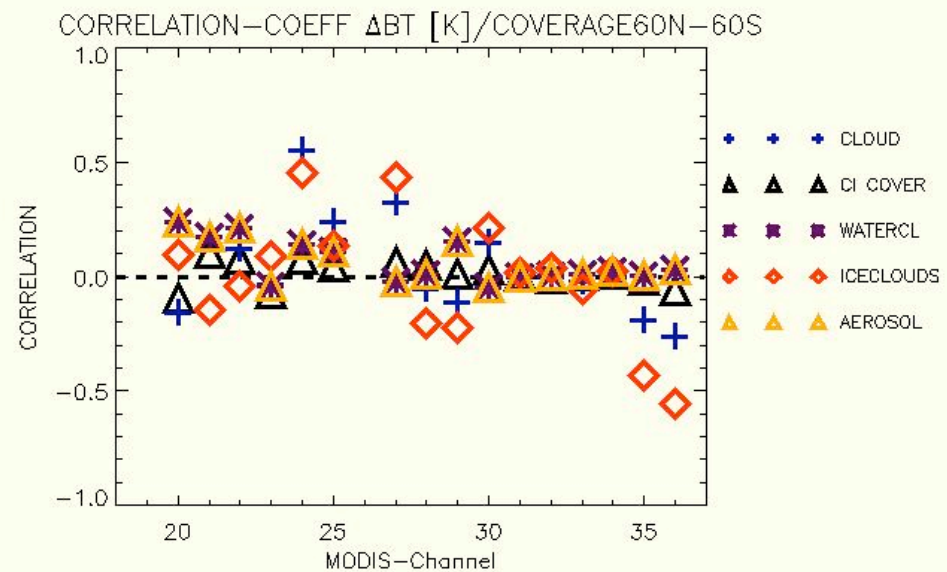
Grey area:
Use of MODIS L2
 e.g.  Ice cloud-flag
or thin Cirrus-Flag (1.38 µm)

# Including Level 2 Data
## Is there a correlation of cloud coverage and ΔBT ?

The variation of ΔBT is reduced by using spatial and spectral response functions and shows strong correlation to most cloud types or aerosol
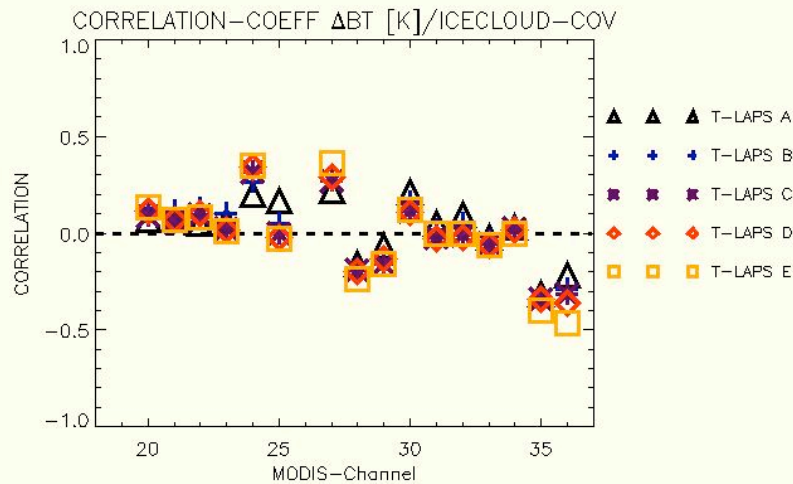


But: there is an interesting correlation to ice clouds outside of the window-channels
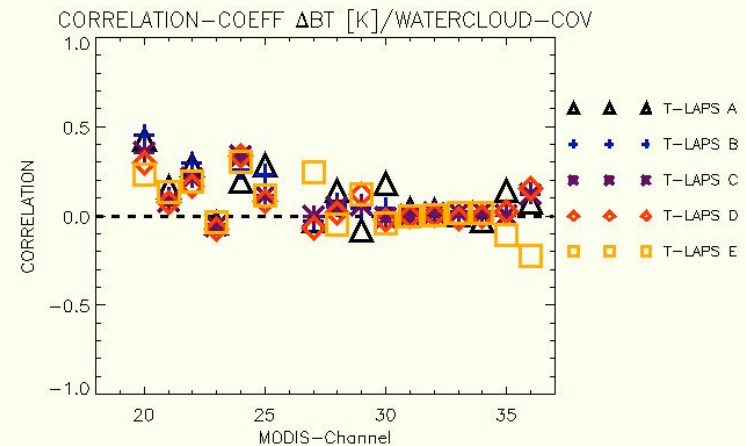
# Including Level 2 Data
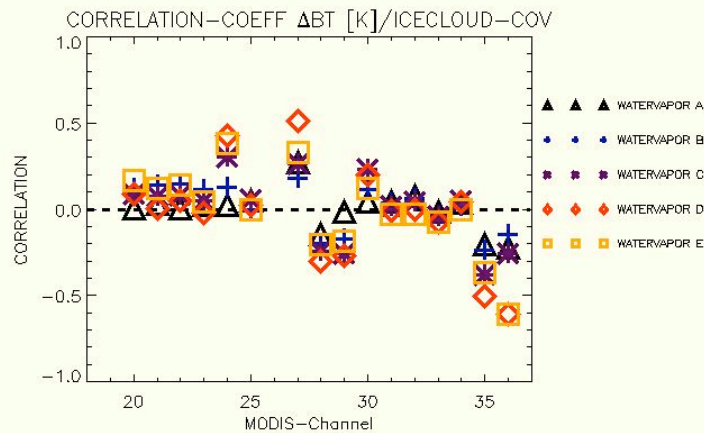## Is there a correlation of cloud coverage and ΔBT
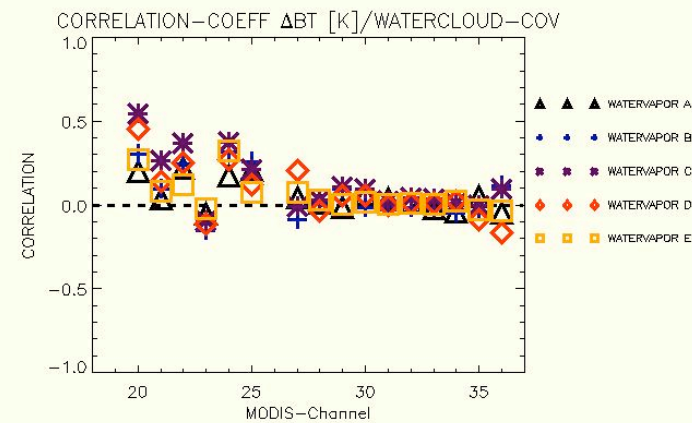## AND AIRS Level 2 - product ?



Increasing lapse rate dT/dp

# Including Level 2 Data
## Is there a correlation of cloud coverage and ΔBT
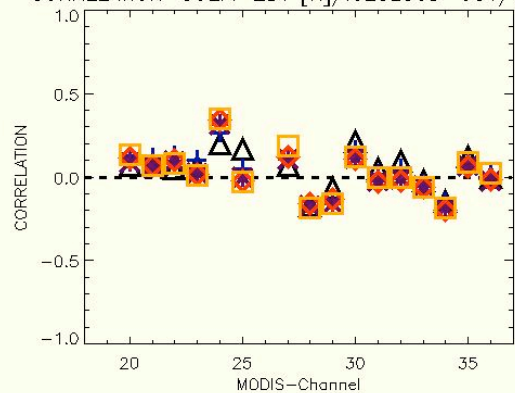## AND AIRS Level 2 - product ?
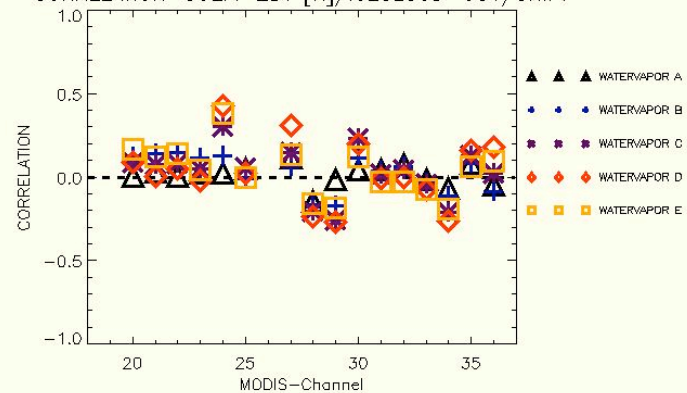


Increasing water vapor

# Including Level 2 Data
## Is there a correlation of cloud coverage and ΔBT
## AND AIRS Level 2 - product ?

The use of the spectral shift for channels
27, 28, 35 and 36 removes the correlation

# Conclusion

- MODIS and AIRS provide the possibility to combine highly accurate spatial and spectral resolution

- Using spectral and spatial response functions (also depending on scan angle) helps to reduce variations of ΔBT

- The behavior of ΔBT for different cloud-types can be analyzed by using the spatial response of AIRS in combination with cloud properties from MODIS

- There are correlations of ice cloud coverage and ΔBT, which are also influenced by temperature gradient and water vapor, if no spectral shift of MODIS is included

- The spectral shift of MODIS is an is an important factor for the combination of the instruments
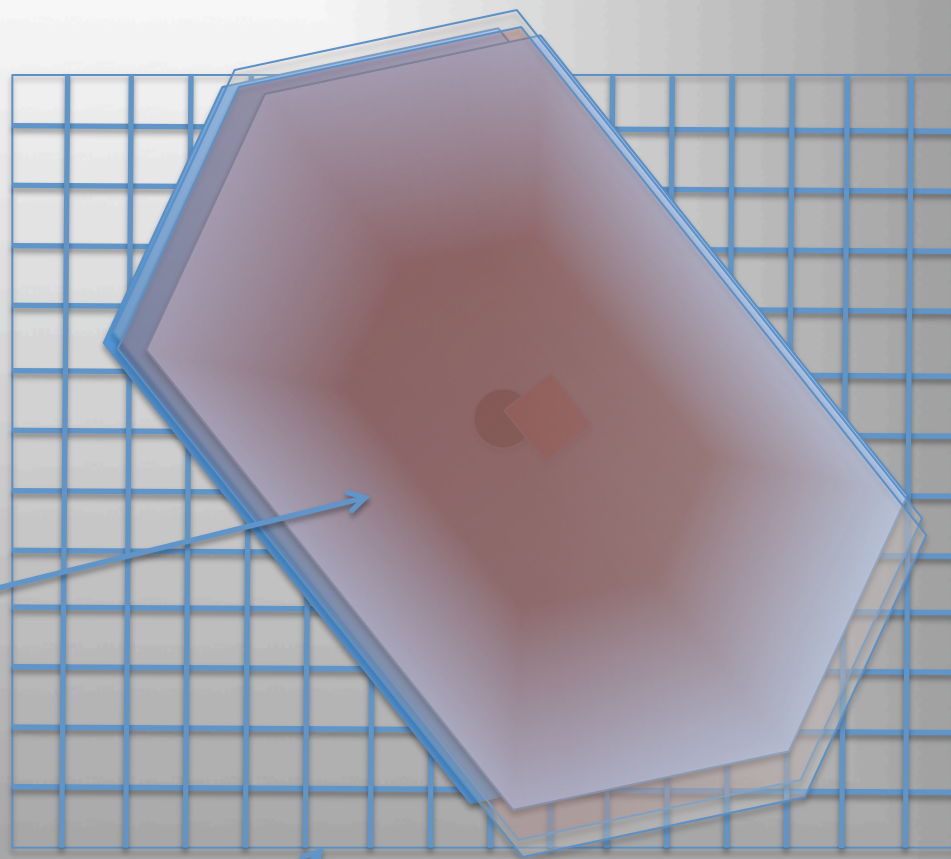
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# Thank you !

# How to (better) combine
## Dependence on Viewing angle

Put the center of the footprint
over the nearest point
and weight the MODIS-pixel according
to the spatial response function
of AIRS and the spectral response
of  the MODIS-channel

AIRS-footprints

MODIS-grid

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